Water Snapshot '97

An Earth Week Survey of the Delaware River and its Tributaries

(Cover graphic by DRBC, Tom Brand)

Water Snapshot '97
Planning and Coordinating Committee

Delaware River Basin Commission
Richard Albert, Warren Huff

Delaware Department of Natural Resources and Environmental Control
Pearl Burbage

Delaware Riverkeeper Network
Fred Stine

Pennsylvania Department of Conservation and Natural Resources, Jacobsburg Environmental Education Center
Estelle Ruppert

Pennsylvania Department of Environmental Protection
Diane Wilson

U.S. Environmental Protection Agency
Diane Calesso, Region II;
Pete Weber, Region III

Volunteers in Service to America (VISTA)
Teresa Halverson

Agency Liaisons

Members of the Planning and Coordinating Committee, plus:

Harry Otto, *Delaware Department of Natural Resources and Environmental Control*
Jim Mumman, *New Jersey Department of Environmental Protection*

Authors

Teresa Halverson, Pete Weber
U.S. Environmental Protection Agency
Robert Limbeck, Richard Albert
Delaware River Basin Commission

Editor

Chris Roberts, *Delaware River Basin Commission*

Water Snapshot '97 logo design

Tom Brand, *Delaware River Basin Commission*

Water Snapshot '97, following its predecessor, *Water Snapshot '96*, continued the Earth Day water quality monitoring event throughout the entire Delaware River Basin. For nine days in April 1997, nearly 80 organizations and more than 350 individuals monitored the waters of the Delaware River Basin. These monitors sampled a total of 358 locations on 174 waterways throughout the Delaware River watershed. Monitors collected over 2,100 pieces of information. These data give us a "snapshot" of the Delaware River watershed, which can be used to examine today's water quality and to serve as a baseline for measuring future water quality. Furthermore, these efforts can be augmented in future Snapshots, to assess watershed quality more fully. For the parameters measured in 1997, the Delaware River Basin water quality is good.

How It Began and How It Has Continued

Water Snapshot ‘96 was conceived as a way of identifying and uniting the numerous water quality monitoring programs that are operating in the Delaware River Basin. Various governmental agencies and the Delaware Riverkeeper Network supported this idea. The result was *Water Snapshot ‘96*, the first basin-wide sampling event ever undertaken in the Delaware River Basin.

The vision of *Water Snapshot ‘96* was a nine-day event, running concurrently with Earth Day, enlisting hundreds of people to test the waters of the Delaware River Basin as a massive display of commitment toward clean water in the basin. Watershed associations, schools, youth organizations, citizen monitoring groups, government agencies, water and sewer departments, industries, environmental professionals, sportsmen, and others collected water quality data. They submitted the data to the Delaware River Basin Commission (DRBC) for analysis.

Water Snapshot ‘96 was a huge success. More than 70 organizations plus many individuals collected water quality information during the event. Twenty-three schools and youth organizations, 20 citizen and watershed groups, 17 governmental agencies, and three private companies joined in the Earth Week project.

Because of the great success of *Water Snapshot ‘96*, *Water Snapshot ‘97* took place from April 19 through 27, 1997, including Earth Week. The purposes for *1997* were the same as for *1996*. In addition, it was hoped that new participants would be attracted to the *Snapshot* event.

To help achieve these goals, a Volunteer in Service to America (VISTA) member served as the full time coordinator. Teresa Halverson was recruited by the U.S. Environmental Protection Agency (EPA), Region III.

The coordinator used mailing lists from the environmental organizations from the four states of the Delaware River Basin (New York, New Jersey, Delaware, and Pennsylvania), the two EPA regions, and participants from *Water Snapshot ‘96*. An introductory flyer was then mailed out to announce the event. Later, a one-page data sheet for recording data was mailed out. Also, the coordinator made presentations at various public meetings to publicize the event.

These efforts led to an increase in the number of participants for *Water Snapshot ‘97*. Overall, 37 school and youth organizations, 27 citizen and watershed groups, 10 governmental agencies, and 5 private companies joined together to sample the waters of the Delaware River Watershed. The total number of people participating in the event was near 400.

The selection of water quality parameters for *Water Snapshot ‘96* had been a critical decision, since the program’s participants would vary from highly scientific organizations to elementary school programs using simple test kits and litmus paper. A small suite of ‘core’ parameters consisting of air and water temperature, pH, dissolved oxygen, nitrate, and phosphate had been chosen and had proven effective.

Recognizing that most programs sampled additional parameters, *Water Snapshot ‘97* asked for any additional tests monitored by the participants. Because of this request, the committee included five optional parameters in *1997*. These were alkalinity, carbon dioxide, coliform, conductivity, and turbidity. The data form also asked participants what type of equipment they used. The two most common testing kits used by the various non-governmental programs were from the LaMotte Company and the Hach Company.

Since many diverse groups participate in *Water Snapshot ‘97*, data are democratized—i.e., all data are lumped together no matter the precision of the analytical method or expertise of the analyst.

Appendix A displays a list of the waterbodies monitored, site description, and the core monitoring data, as was done in Appendix D of the *1996* report.

Appendix B displays the names, addresses, and phone numbers of the *Water Snapshot ‘97* participants. Based on the individual participants, 14 percent were from Delaware, 18 percent from New Jersey, 8 percent from New York, and 60 percent from Pennsylvania. In addition, results from the five optional monitoring parameters are listed here.

The Delaware River Basin: Environmental Setting

The Delaware River Basin is a fairly small watershed in comparison with those of other major U.S. rivers. In land area, the basin drains 12,765 square miles, which is only 0.4% of the U.S. total. However, the basin seems much larger considering the fact that almost 7% of the U.S population depends upon the Delaware Basin as its source of water supply. Blessed by 44 inches of rainfall per year, the basin is able to support not only the 7.5 million residents within its boundaries, but another 10 million outside the basin in New York City and northern NJ. The Delaware Basin also serves to supply many industrial, agricultural, commercial, and recreational needs.

It was not long ago when the many demands placed upon Delaware River water nearly killed the river itself, for in addition to serving as a water supply for so many people and their activities, the river also served as an open sewer. At the height of World War II, many reaches of the river were devoid of life due to lack of oxygen. Since then, the river has been brought back to life. Much of the credit for restoration of the river has been given to creation of the federal Clean Water Act, the E.P.A. and the Delaware River Basin Commission. These agencies were not alone in their heroic efforts. Since the 1970's environmental movement, government agencies have been aided greatly by watchful citizen monitors. Recognizing that government alone cannot preserve the outstanding water quality of the Delaware, regular people banded together to take ownership of their local waterways, and to preserve their valuable water resources for future generations. Just as the Delaware River Basin is composed of many smaller watersheds (also called sub-basins), the citizen monitors listed in the appendices of this document contribute to a much larger collective effort.

A Tour of the Delaware River Watershed

Along its 330-mile path to the Atlantic Ocean, the Delaware River collects water from ecologically diverse tributaries, influenced by wide-ranging natural and human-induced conditions which dictate its water quality. The major tributaries to the Delaware are the Lehigh and Schuylkill Rivers in Pennsylvania. Both of these watersheds have been subject to by-products of intensive coal mining in their headwaters. Major towns along each tributary include: Allentown, Bethlehem and Easton along the Lehigh River, and Pottsville, Reading, Pottstown, Norristown, and Philadelphia along the Schuylkill River.

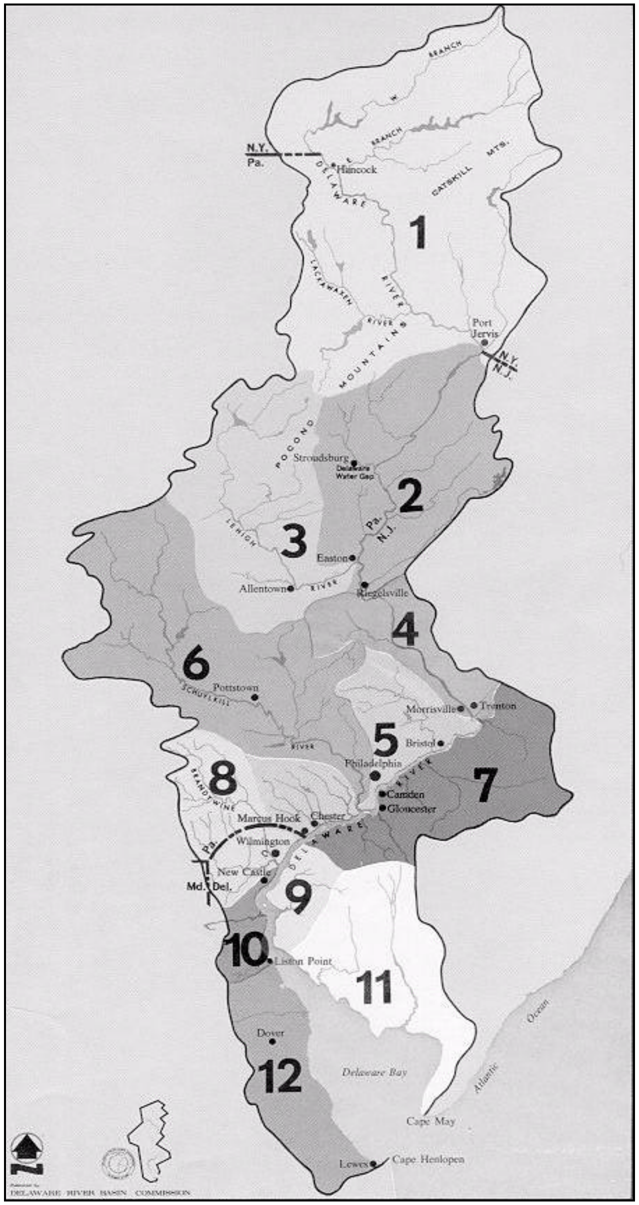
The cold, clear, highly oxygenated mountain streams of the New York Catskill Mountains form the headwaters of the Delaware River Basin, draining into the East and West Branches of the Delaware River, which meet at Hancock, NY. This northern region is known to geologists as the glacier-carved Upland physiographic province. This area is home to the Upper Delaware National Scenic and Recreational River as well as the Middle Delaware Scenic and Recreational River, both of which have been included in the National Wild and Scenic Rivers System. Once the river breaks through the main ridge of the Appalachians at Delaware Water Gap, it flows through broad valleys past the rolling hills of the Piedmont. Here the streams are a bit less sloped, flow is a little slower, light penetration is greater, the substrate is less influenced by the glacial origin of the rock, and the land includes less forest and more farmland and suburban sprawl.

Past the fall line at Trenton, the river flows through the Coastal Plain of New Jersey, southeastern Pennsylvania and Delaware in the tidal Delaware Estuary. The major influence on water quality in the Lower Delaware is urbanization. The river flows past Trenton, Camden, Philadelphia, Chester and Wilmington, a highly populated urban complex with major ports and industries. Tributaries along this reach of river have felt the effects of a few hundred years of development and industrialization, and must accommodate further rapid growth in their headwaters now that our population has shifted out of the cities and into the ever-growing suburbs. Many of these tributaries are especially in need of protection by citizen monitors, and are close to most of our back yards.

Below Wilmington, the river widens into Delaware Bay, where the land is flat, the shores are marshy, and agriculture dominates the inland landscape. Some industry exists where petrochemical and power plants require cooling water, but most other human-induced effects on water quality originate from poultry and vegetable farming. Feeder streams flow slowly, meander, and are generally warmer than the mountain streams in Pennsylvania and New York. Major tributaries to the bay include the Salem, Cohansey and Maurice Rivers (a National Wild and Scenic River) in New Jersey, and the Chesapeake & Delaware Canal and the Smyrna, Leipsic, Murderkill, and Broadkill Rivers in DE. Water quality in the bay is heavily influenced by the tides, which may cause great variation in local water quality. Before feeding into the Atlantic Ocean between Cape May, New Jersey, and Cape Henlopen, Delaware, the bay encompasses an extremely rich and diverse ecosystem known for its fisheries, horseshoe crabs, and huge flocks of migratory birds.

Sub-Basins of the Delaware River Watershed

For the purpose of defining the geographic extent of sampling which occurred during Snapshot '97, sample locations were assigned sub-basin numbers (see Appendix A). Though some of the DRBC sub-basin boundaries are political rather than hydrologic divisions, their utility has proved useful toward defining the extent of sampling coverage for this study. The following definitions include lists of major tributaries to the Delaware River which are located in each sub-basin. Some discussion of sampling effort is included along with the sub-basin descriptions.



Sub-Basin 1: Upper Basin (NY and PA)

Drainage in New York, Pennsylvania, and a very small part of New Jersey, including tributaries entering the Delaware River above the USGS stream flow gauge at Montague, NJ, located at Delaware River mile 246.3. The approximate drainage area totals 3,422 square miles. In New York, the major tributaries to the Delaware River include: East Branch Delaware River, West Branch Delaware River, Callicoon Creek, Tenmile River, Mongaup River, and the Neversink River. In Pennsylvania, major tributaries include: Equinunk Creek, Lackawaxen River, and Shohola Creek. Sub-basin 1 includes the National Park Service Upper Delaware Scenic and Recreational River. 36 samples were taken from locations in sub-basin 1.

Sub-Basin 2: Middle Delaware (NJ and PA)

Drainage in New Jersey and Pennsylvania between the streamflow gauge at Montague, NJ (river mile 246.3) and the gauge at Riegelsville, NJ (river mile 174.8). Excludes the Lehigh River watershed. The approximate drainage area is 1,542 square miles. In New Jersey, major tributaries include: Flat Brook, Paulins Kill, Pequest River, Pohatcong Creek, Lopatcong Creek, and the Musconetcong River. Pennsylvania tributaries include: Sawkill Creek, Raymondskill Creek, Dingmans Creek, Bush Kill, Brodhead Creek, Cherry Creek, Martins Creek, and Bushkill Creek. Sub-basin 2 includes the National Park Service Middle Delaware Scenic and Recreational River. 55 samples were taken from locations in sub-basin 2.

Sub-Basin 3: Lehigh River Watershed (PA)

The Lehigh River drainage area encompasses 1,364 square miles, entering the Delaware River at Easton, PA. Tributaries to the Lehigh include: Tobyhanna Creek, Bear Creek, Black Creek, Nesquehoning Creek, Mahoning Creek, Pohopoco Creek, Lizard Creek, Aquashicola Creek, Hokendaqua Creek, Little Lehigh Creek, Monocacy Creek, and Saucon Creek. 41 samples were collected from sites located in sub-basin 3.

Sub-Basin 4: Lower Delaware to Trenton (NJ & PA)

This is the drainage area, composed mostly of small Delaware River tributaries, located between the USGS gauge at Riegelsville, NJ (river mile 174.8), and the USGS gauge at Trenton, NJ (river mile 134.3). The approximate drainage area is 452 square miles. New Jersey tributaries include: Hakihokake Creek, Harihokake Creek, Nishisakawick Creek, Copper Creek, Warford Creek, Lockatong Creek, the Delaware and Raritan Canal water diversion point, Wickecheoke Creek, Alexauken Creek, Swan Creek, Moore Creek, Fiddler Creek, Jacobs Creek, and Gold Run. Pennsylvania tributaries include: Cooks Creek, Gallows Run, Tinicum Creek, Tohickon Creek, Hickory Creek, Paunnacussing Creek, Rabbit Run, Dark Hollow Run, Pidcock Creek, Jericho Creek, Houghs Creek, Dyers Creek, and Buck Creek. 11 sites were sampled in sub-basin 4, mostly on the Delaware River.

Sub-Basin 5: Upper Estuary Tributaries (PA)

This is the drainage area in Pennsylvania between the Trenton gauge (river mile 134.3) and the Pennsylvania-Delaware state boundary near Marcus Hook, PA (river mile 78.8). This sub-basin excludes the Schuylkill River watershed above Fairmount Dam in Philadelphia, PA. The confluence of the Schuylkill into the Delaware (river mile 92.5) divides sub-basin 5 into minor basins 5A (upstream of the Schuylkill) and 5B (downstream of the Schuylkill). The approximate combined drainage area of sub-basin 5 is 678 square miles. Tributaries to the Delaware River located in sub-basin 5A include: Mill Creek, Neshaminy Creek, Poquessing Creek, Pennypack Creek, and Frankford Creek. Sub-basin 5B tributaries to the Delaware River include: Darby Creek, Crum Creek, Ridley Creek, Chester Creek, and Marcus Hook Creek. 32 sites were sampled in sub-basin 5A, and 27 sites were sampled in sub-basin 5B.

Sub-Basin 6: Schuylkill River Watershed (PA)

This is the Schuylkill River watershed above Fairmount Dam in Philadelphia, PA. The Schuylkill River empties into the Delaware River at river mile 92.5. Fairmount Dam is located at Schuylkill river mile 8.5. Below Fairmount Dam, the Schuylkill River is tidal and different in character from the upstream drainage area. The approximate drainage area is 1,893 square miles. Major tributaries to the Schuylkill River include: West Branch Schuylkill River, Little Schuylkill River, Maiden Creek, Tulpehocken Creek, Manatawny Creek, French Creek, Pickering Creek, Perkiomen Creek (including Unami Creek, Swamp Creek, East Branch Perkiomen Creek, and Skippack Creek), and Wissahickon Creek. In 1996, the Schuylkill River was under-represented in sampling effort (the main stem was sampled just once). In 1997, the Schuylkill River watershed was sampled 88 times on 49 tributaries, and the main stem was sampled 13 times. This makes the Schuylkill watershed the most highly represented among all of the Delaware River waterhsheds for Snapshot ’97.

Sub-Basin 7: Upper Estuary Tributaries (NJ)

In New Jersey, this is the drainage area located between the USGS gauge at Trenton (river mile 134.3) and the point opposite the Pennsylvania-Delaware state boundary (river mile 78.8) at Nortonville, NJ, which is just seaward of the mouth of Raccoon Creek in New Jersey. Sub-basin 7 is divided into sub-basins 7A and 7B at a point just seaward of the mouth of Woodbury Creek in New Jersey (river mile 91.6). The approximate combined drainage area of sub-basin 7 is 1,019 square miles. Tributaries to the Delaware River in sub-basin 7A include: Crosswicks Creek, Blacks Creek, Crafts Creek, Assiscunk Creek, Rancocas Creek, Swede Run, Pompeston Creek, Pennsauken Creek, Pohack Creek, Baldwin Run, Cooper River, Newton Creek, Big Timber Creek, and Woodbury Creek. Sub-basin 7B tributaries include: Little Mantua Creek, Mantua Creek, Clonmell Creek, Nehonsey Brook, Repaupo Creek, and Raccoon Creek. 19 sites were sampled in sub-basin 7, though most of the largest tributaries were missed, including the Rancocas and Mantua watersheds.

Sub-Basin 8: Brandywine-White Clay-Christina (PA, DE)

This is the drainage area in Pennsylvania and Delaware between the PA-DE state boundary at Marcus Hook, PA (river mile 78.8) and a point just seaward of the mouth of the Christina River in Delaware (river mile 70.7). The approximate drainage area is 591 square miles. Tributaries include: Naaman Creek, Christina River, White Clay Creek, Red Clay Creek, West Branch Brandywine Creek, East Branch Brandywine Creek, and the Brandywine Creek. 23 sites were sampled in sub-basin 8.

Sub-Basin 9: Lower Estuary Tributaries (NJ)

In New Jersey, this is the drainage area between Delaware River mile 78.8 at Nortonville, NJ, and the mouth of the Delaware River (head of Delaware Bay) at Hope Creek Monument (opposite Liston Point, DE) at river mile 48.2. The approximate drainage area of sub-basin 9 is 257 square miles. Tributaries include: Oldmans Creek, Salem River, and Alloways Creek. 8 sites were sampled in sub-basin 9.

Sub-Basin 10: Lower Estuary Tributaries (DE)

In Delaware, this is the drainage area from a point just seaward of the mouth of the Christina River (river mile 70.7) to the mouth of the Delaware River (head of Delaware Bay) at Liston Point (river mile 48.2). This sub-basin is broken into minor sub-basins 10A and 10B at the Chesapeaake & Delaware Canal (river mile 58.9). The approximate combined drainage area of sub-basin 10 is 166 square miles. Tributaries to the Delaware Estuary in sub-basin 10 include: Red Lion Creek, Dragon Creek, C & D Canal, Augustine Creek, Appoquinimink River, Hangmans Run, and Blackbird Creek. 3 samples were taken from sites located in sub-basin 10.

Sub-Basin 11: Delaware Bay Tributaries (NJ)

In NJ, this sub-basin includes the drainage area from the Hope Creek Monument (head of Delaware Bay) at river mile 48.2 to the mouth of Delaware Bay at Cape May, NJ (river mile 0). Sub-basin 11 is divided into minor basins 11A and 11B, just below the confluence of the Maurice River (river mile 21.02). The combined drainage area of sub-basin 11 is 769 square miles. Tributaries to Delaware Bay located in sub-basin 11 include: Stowe Creek, Cohansey River, Cedar Creek, Nantuxent Creek, Oranoaken Creek, Dividing Creek, Maurice River, West Creek, Dennis Creek, Fishing Creek and the Cape May Canal. The Maurice River is included in the National Wild and Scenic Rivers system, serving the towns of Vineland and Millville, NJ, yet was never sampled during Snapshot ’97. The Cohansey River watershed, which contains the town of Bridgeton, NJ, was sampled just once. No lower Delaware Bay tributaries in sub-basin 11B were sampled.

Sub-Basin 12: Delaware Bay Tributaries (DE)

In Delaware, this sub-basin includes the drainage area between the head of Delaware Bay at Liston Point (river mile 48.2) and the mouth of Delaware Bay at Cape Henlopen (river mile 0). Sub-basin 12 is divided into minor basins 12A and 12B at a point just seaward of the St. Jones River (river mile 23.7). The combined drainage area of sub-basin 12 is 612 square miles. Tributaries to Delaware Bay in sub-basin 12 include: Smyrna River, Leipsic River, Mahon River, Little River, St. Jones River, Murderkill River, Mispillion River, Broadkill Creek, and Roosevelt Inlet (entrance to the Lewes & Rehoboth Canal). 14 samples were taken from sites located in sub-basin 12.

Snapshot ’97 Sampling Effort, a Look at the States

State Distribution of Waterways Sampled, with a Comparison to Snapshot ’96. This table shows that the majority of streams sampled for Snapshot ’97 were located in Pennsylvania. A particular area of improvement from 1996 to 1997 was the effort applied to coverage of the Schuylkill River Basin. This table also shows that New Jersey sampling was not as extensive as in 1996, and should be better represented during future events. In particular, tributaries to the Delaware Estuary and Delaware Bay need to be sampled more (see sub-basin descriptions and sampling summaries).

	% of 1996 Waterways Sampled	**% of 1997 Waterways Sampled**	**No. of 1997 Waterways Sampled**	**% of DRB Land Area**
PA	51	67	116	47
NJ	28	13	23	22
NY	13	10	16	17
DE	7	9	17	7

Water Quality Findings

Water Snapshot '96 indicated that, overall, the Delaware River Basin water quality was in good condition. The Delaware River, the main stem of the Basin, was also in good condition. Many people and organizations cared enough about the Basin's waters to take the time and effort to monitor its waters, ranging from small streams to large rivers. This snapshot effort suggested that there was an important constituency who would be available to help protect the Delaware Basin.

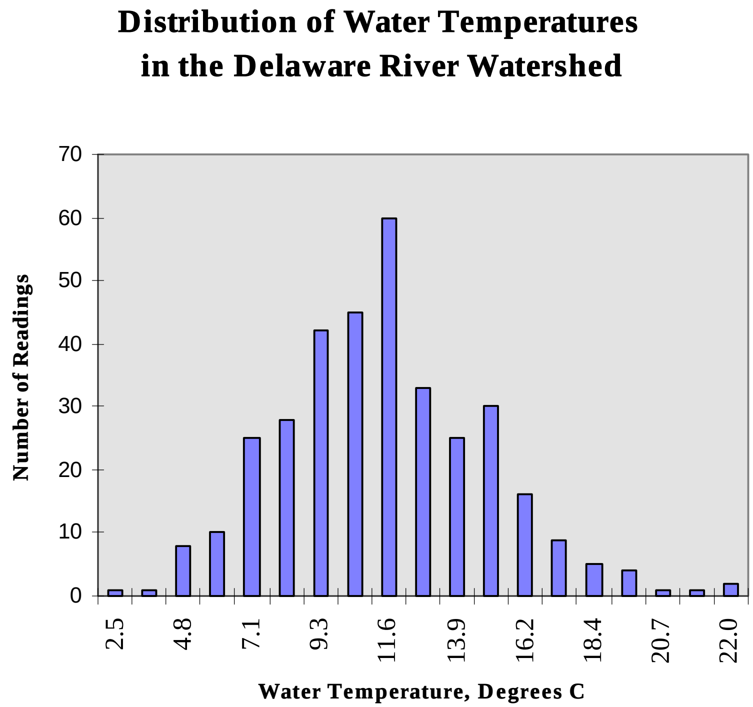
Water Snapshot '97 verified the results of *1996*. Once again, numerous people and organizations are looking after the Basin's waters. The condition of these waterways is good. The need for increased monitoring of the Schuylkill River, suggested in the *1996* report, was amply taken care of in *1997*.

The local-scale, site-by-site picture, which is still the heart of *Snapshot*, is seen in Appendix A. Participants, listed in Appendix B, monitored more than 350 sites within the Basin during the nine-day period.

Water Temperature

Water Temperature is an important environmental factor for fish and other aquatic life, with many species needing specific temperature ranges to thrive. Temperature affects the concentrations of dissolved oxygen in water, with higher concentrations occurring with colder temperatures. The average water temperature of all sampling sites in the basin was 10.9°C (51.6°F). This average is about 2.7°C (4.9°F) lower than the Basin-wide water temperature of *Water Snapshot '96*.

Distribution of Water Temperatures in the Delaware River Basin Watershed. The range of temperatures from *1997* is similar to the range found in *Snapshot '96*. The values reflect nine days of monitoring in the Springtime, in locations ranging from the mountains to the coastal plain.



Dissolved Oxygen

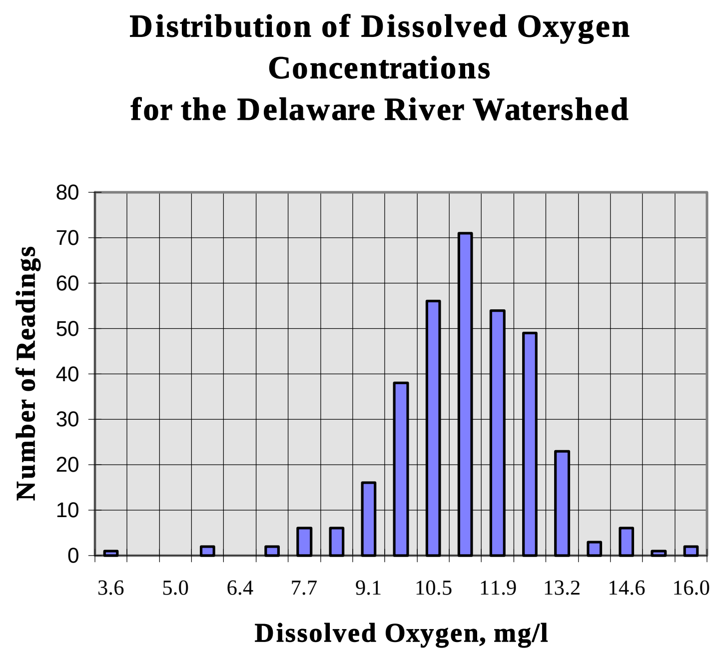
The amount of oxygen that can be dissolved into water is dependent on temperature. For any temperature, the maximum dissolved oxygen (DO) concentration that can be achieved is called the saturation value. If the water temperature rises, the saturation value falls; if the temperature falls, the saturation value rises, allowing greater concentrations of DO.

In natural streams, saturation values generally will be above 90 percent, but less than 100 percent, because of naturally occurring organic material in the water. The exception occurs when aquatic plant photosynthetic activity during daylight raises dissolved oxygen concentrations temporarily above 100 percent saturation. On the deficit side, pollution by discharges of oxygen-demanding materials like improperly treated sewage can drastically lower dissolved oxygen concentrations.

In general, DO levels above 6 milligrams per liter of water, or 6 mg/l, (equivalent 6 parts per million) provide full support of fish and other aquatic life. Levels of 4 or 5 mg/l are often acceptable, but levels lower than that lead to reductions in populations. The exact requirement for DO varies by species, with some being very tolerant and others being intolerant —and, thus, more susceptible—to the effects of water pollution.

Water Snapshot '96's DO concentration levels were a bit lower than *Snapshot '97*. *Snapshot '96*'s average water temperature was 13.6°C. This temperature would have 100 percent saturation value at 10.3 mg/ l dissolved oxygen. The 1996 mean dissolved oxygen concentration was 9.9 mg/l; the hypothetical percent saturation for the basin as a whole would be 96 percent.

Distribution of Dissolved Oxygen Concentrations for the Delaware River Basin Watershed. *Water Snapshot '97* collected 336 samples of dissolved oxygen concentrations. The mean DO concentration was 10.8 mg/l. This value represents a hypothetical saturation value of 100.9 percent, given the basin's mean water temperature of 10.9 °C. The high DO value makes sense because the colder water is able to hold more oxygen. Low saturation values were found at sites on Cobbs Creek and Poquessing Creek in Philadelphia, and on the Delaware River at Pea Patch Island and Ship John Light, indicating potential problem spots.



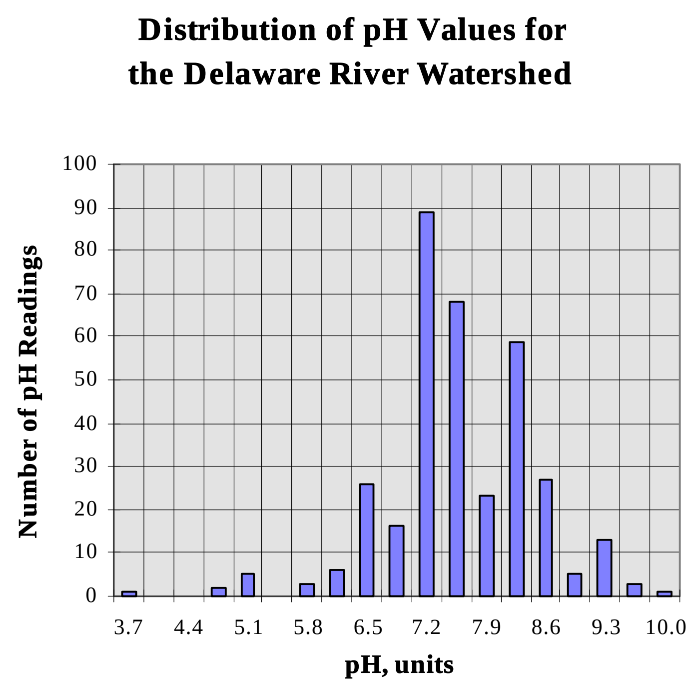
pH

pH is a measure of the acid/alkaline relationship in a stream. pH values range on a scale of zero to 14, with 7 being neutral. Since pH is logarithmic, a one-notch change in pH (e.g., from 6 to 7) represents a 10-fold increase.

A pH of about 6 to 9 is generally favored by aquatic life, especially fish. Algae and rooted plants in a stream modify pH levels through the photosynthesis and respiration processes. If plants are active, wide swings in pH levels can be observed over a 24-hour period, with low values experienced at night and high values experienced at midday. Plant use and release of carbon dioxide cause these swings in the water column. In-stream pH levels can also be impacted by acid and alkaline chemicals from industry, mining, and other man-made sources, as well as by natural sources such as limestone deposits (bedrock) and tannic acid (produced by certain vegetation).

Values of pH below 6 should be viewed with concern, unless a natural condition exists that can explain them. On the Pocono Plateau, in the Tobyhanna & Tunkhannock Creek watersheds, the water is acidic and appears tea-colored. The area is dominated by thick stands of pine, and the ground is boggy wetlands. The reason for low pH values in these streams is the tannic acid from the pine trees.

Distribution of pH values for the Delaware River Basin Watershed. The average pH for *Water Snapshot '97* was 7.4. Most of the monitoring sites fell within the desired pH range. Of 347 pH samples, 11 were below 6 (9 of these in the tannic acid-rich Tobyhanna & Tunkhannock Creek area) and nine were above 9. Of these, most had DO values in the super-saturation range, indicating aquatic plant activity.



Nitrate and Phosphate

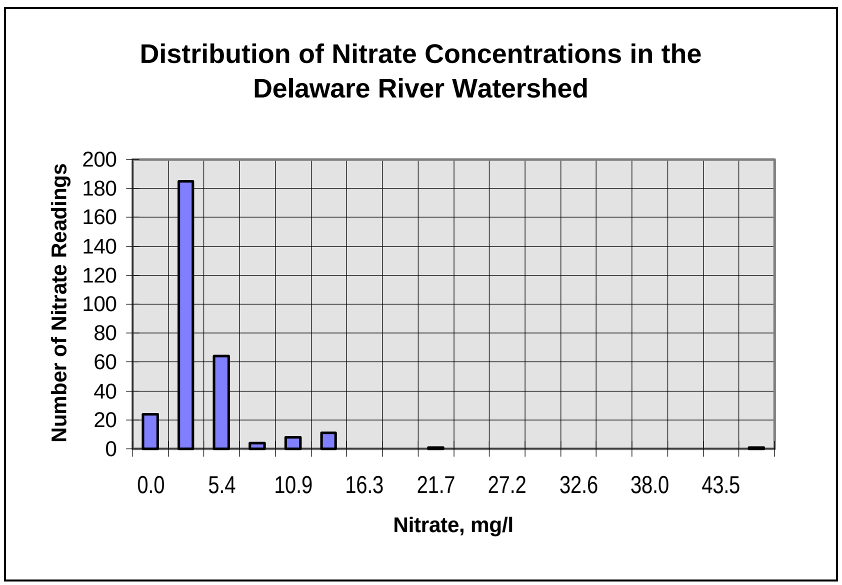
Nitrate and phosphate are necessary for aquatic plant growth, which supports the rest of the aquatic food chain. Both of these nutrients are derived from a variety of natural and artificial sources, including decomposition of plant and animal materials, man-made fertilizers, and sewage. While excessive nutrients might cause undesirable plant growth with their deleterious impacts on water quality, an appropriate level of nutrients is one of the driving forces of the aquatic ecosystem.

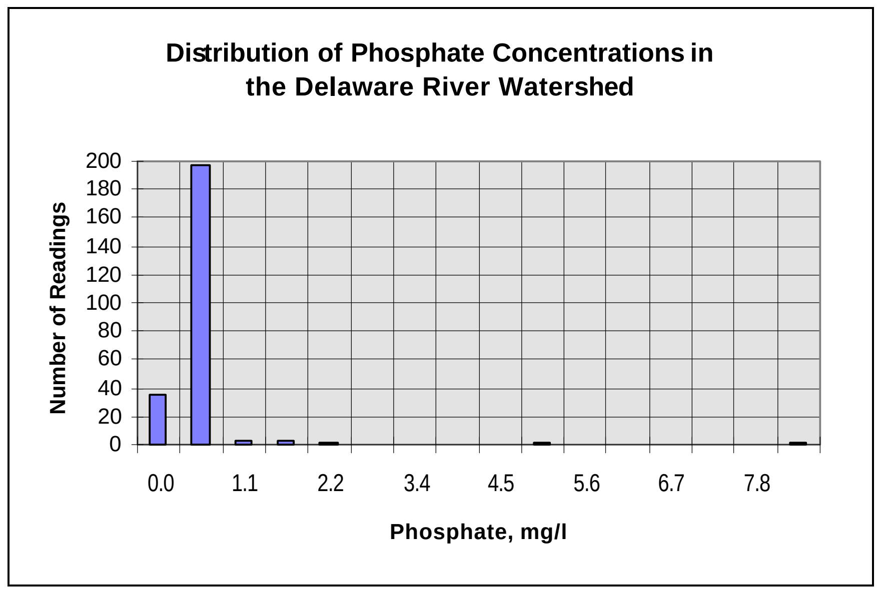
Determining the optimum levels of nitrates and phosphates in water is extremely complex. A concentration of nitrate or phosphate that causes problems in one stream might not cause similar problems in another. Nitrate and phosphate levels are also complex because they are constantly being taken up and released by aquatic life, being exchanged with stream bed sediments, and undergoing various other transformations.

Natural nitrate concentrations rarely exceed 10 mg/l. Most are less than 1 mg/l, especially during periods of high plant production. Concentrations greater than 20 mg/l may pose a health hazard to babies and other small mammals, causing a problem where the blood's hemoglobin cannot transport oxygen.

Man-made sources of phosphate include fertilizers, domestic sewage, and detergents. In natural unpolluted water, phosphate levels are generally very low, and its presence usually determines plant growth. Phosphorus, which combines with oxygen to form phosphate, is most often the limiting factor for plant production in streams.

Distribution of Nitrate and Phosphate Concentrations in the Delaware River Watershed. To determine whether levels are excessive or not, check concentrations at nearby streams in Appendix A, or check value against these frequency histograms.





DELAWARE RIVER FINDINGS

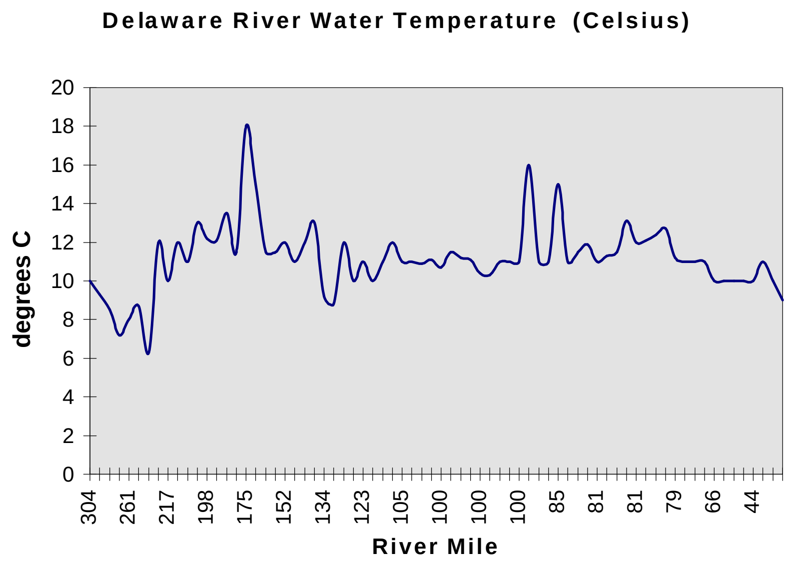
Small headwater streams flow out of springs, down mountainsides, and through fields and wetlands to join with other headwater streams. These larger streams flow into other larger streams until ultimately a tributary flows into the Delaware River somewhere along its route to the Atlantic Ocean. The Delaware thus integrates the water quality, flow, land uses, and other attributes of hundreds of watersheds that drain the Delaware River Basin. The Delaware River and its water quality are the sum of these parts.

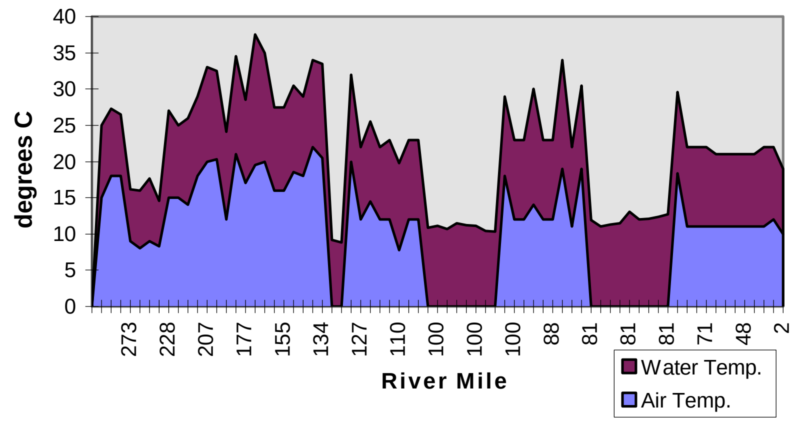
During Water Snapshot '97, the Delaware River/Bay was sampled 74 times at 50 different locations. By comparison, the river was sampled only 48 times during Water Snapshot '96. Sampling the river were various federal, state, and local agencies; industries; youth organizations; citizens; and others. DRBC celebrated Secretary's Day by having its secretaries spend a day in the field collecting data at various river sites.

The following data profiles compile the river data collected during *Water Snapshot '97*. Trends and other information that can be identified in the profiles are discussed.

Water Temperature

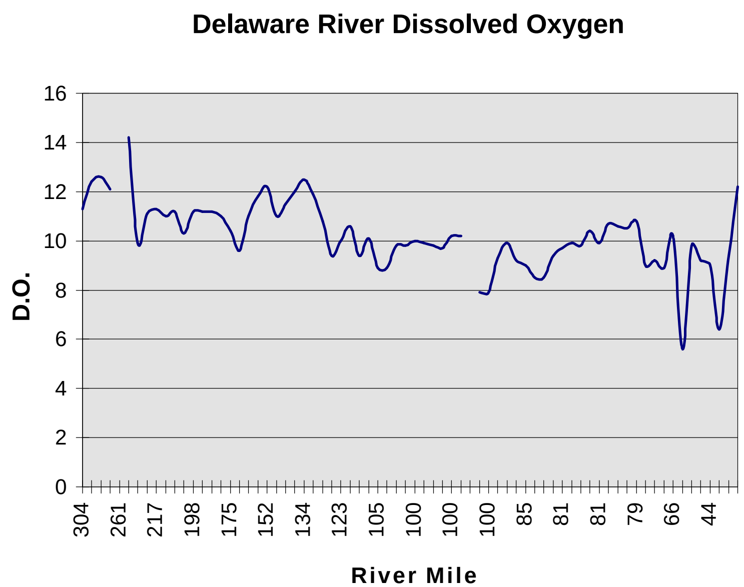
In general, an increasing trend in water temperature is observed in the non-tidal river from Hancock, New York (mile 331) to Trenton, New Jersey (mile 133) with relatively constant water temperatures in the tidal Delaware Estuary and Bay (miles 133 to 0). The influence of some large tributaries and thermal discharges are probably seen in the spikes. The profile is generally similar to 1996, but lower. When air and water temperatures are shown together, the influence of each on the other is readily apparent. It should not be assumed that air temperature is influencing water temperature, since a large river like the Delaware influences the climate nearby.



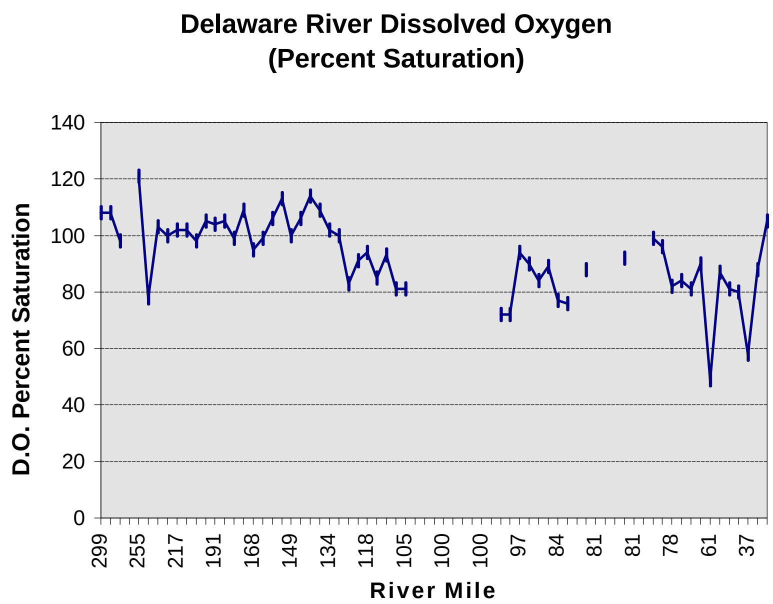


Dissolved Oxygen

Dissolved oxygen generally declines from the upper-most reaches of the river to the lower reaches of the Delaware Estuary. This is due to water temperature differences as described previously, and also because the downstream reaches of the river are more urbanized and subject to more wastewater treatment plant discharges. During Water Snapshot'97, however, dissolved oxygen levels throughout the Delaware were more than adequate to support the migration and spawning of important migratory fish like the American Shad. However, the low values (for April) observed at River Miles 61 (Pea Patch Island) and 37 (Ship John Light) suggest a possible problem that requires investigation.

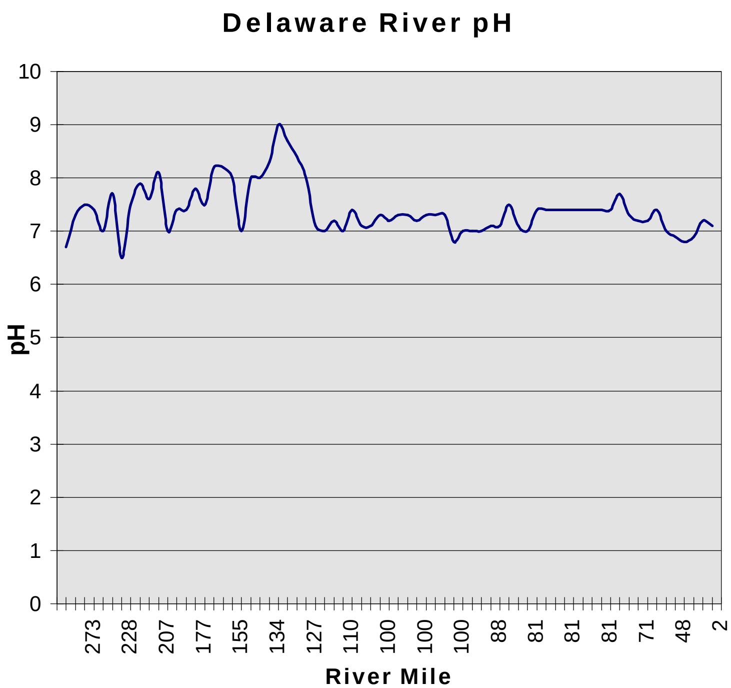


While dissolved oxygen data provides useful information, additional information is derivable by combining D.O. data with water temperature data and calculating percent D.O. saturation. As shown below, various locations in the upper Delaware reaches indicate possibly excessive algal photosynthesis (saturation above 100) while some locations downstream of Trenton, New Jersey, (mile 134) particularly around Philadelphia and Camden, show impacts from the large amount of oxygen-demanding wastewater being discharged into the Delaware Estuary (saturation values below 95 or so).



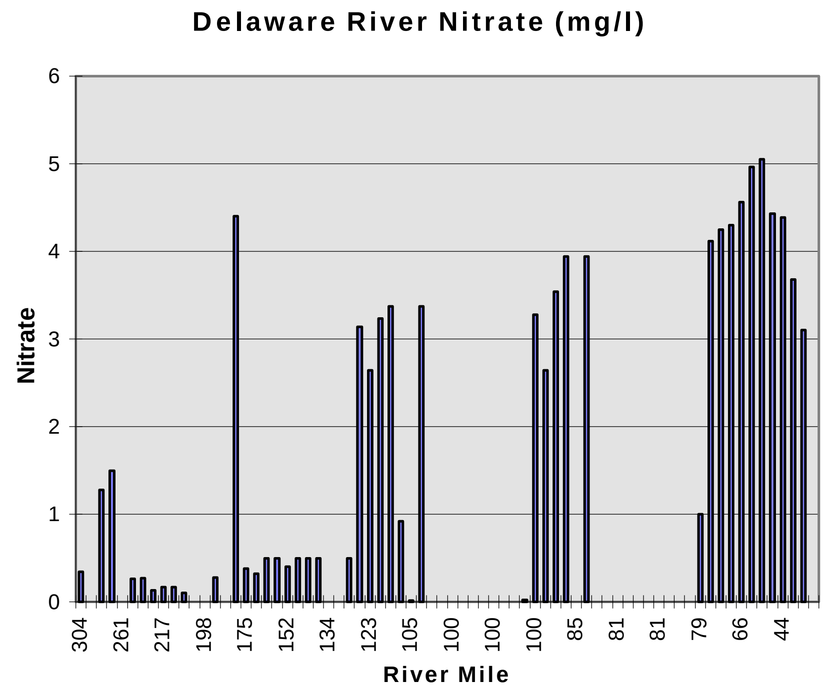
pH

Values for pH were generally higher and more variable in the non-tidal river than in the Delaware Estuary and Bay.   The pattern of pH observed during Water Snapshot ’97 suggests that biological reactions (notably photosynthesis) were actively occurring in the non-tidal reach of the river, but less noticeable in tidal waters. Tidal waters (Delaware Estuary and Bay) are generally more turbid and thus provide light-limited conditions. Photosynthesis by algae and other aquatic plants is dependent on sunlight. Low pH conditions observed during Water Snapshot ’96 at Bordentown, NJ were not observed in 1997.



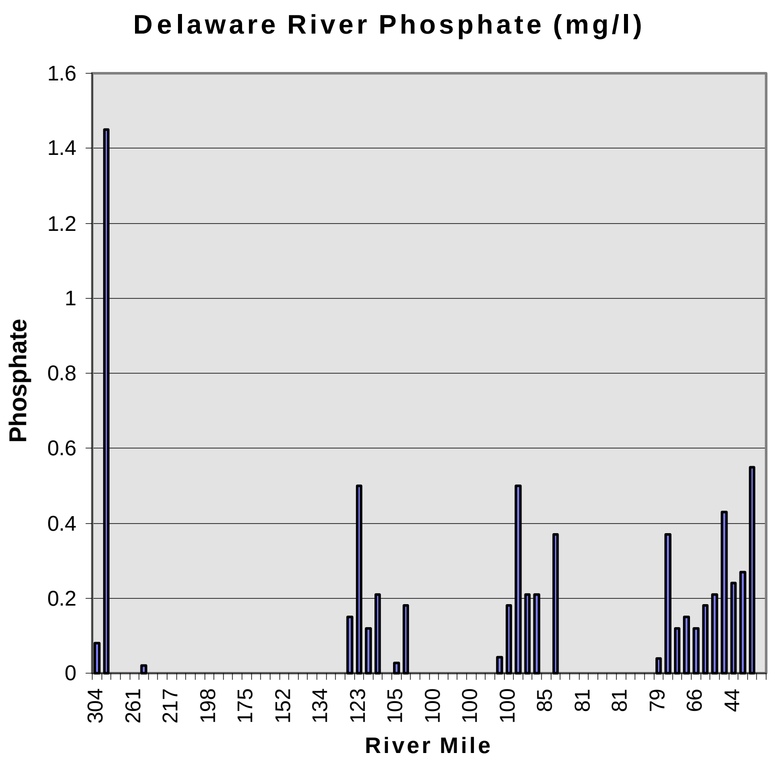
Nitrate

Nitrate shows a general increase from upstream to downstream until the upper Delaware Bay is reached. In past decades, the Delaware Estuary was dominated by ammonia forms of nitrogen, but the upgrading of wastewater treatment plants has resulted in a system dominated by nitrate, a good trend. The regions of higher nitrate concentrations are due to nitrate loads coming into the system from urban areas and large tributaries including the Lehigh River at mile 184 and very large treatment plants after mile 104. Decreases in nitrate in the upper section of Delaware Bay (after mile 55) are due to dilution by sea water.



Phosphate

Phosphate's pattern in the Delaware River system is somewhat similar to nitrate's. Human sources of phosphate appear to dominate. This trend is quite pronounced in the Delaware Estuary (downstream of mile 133). Particularly interesting in 1997 was the high spike shown at mile 299 (the Damascus, Pa - Cochecton, NY bridge). The source of this high phosphate value, whether from a reservoir release, agricultural runoff, sampling error etc., is unknown.



Summary

Between April 19 and 27, 1997 a huge flash bulb went off over the Delaware River Basin as 79 organizations and hundreds of people took the second "snapshot" of Basin water quality. Climbing down stream banks, hanging from bridges, and wading in still-cold water, these folks collected an estimated 2100 pieces of data at 350 locations on 172 streams. The picture of water quality and, more importantly, the interest of the participants, is a good one. As Water Snapshot '97 is pasted into the Delaware River Basin album, planning for 1998 is well underway. See you out there!